PCT/GB 2004 / 0 0 2 3 2 9

The Patent Office

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 0 6 AUG 2004
WIPO PCT

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

e-regis ion under the Companies Act does not constitute a new legal entity but merely ıbjects company to certain additional company law rules.

Signed

Dated 21 July 2004

Patents Form 1/77

P[illegible]ts Act 1977
(Rule 16)

THE PATENT OFFICE
F
11 MAR 2004

The Patent Office — PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS

11MAR04 E880077-2 D02884
P01/7700 0.00-0405454.0 CHEQUE

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference — P36765-/NGR/DBR/GMU

2. Patent application number *(The Patent Office will fill this part in)* — 0405454.0 — 11 MAR 2004

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — DES Enhanced Recovery Limited
Westhill Business Centre
Arnhall Business Park
Westhill
Aberdeen
AB32 6US

Patents ADP number *(if you know it)* — 8642258001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — "Apparatus and Method for Recovering Fluids from a Well"

5. Name of your agent *(if you have one)* — Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* — 165-169 Scotland Street
Glasgow
G5 8PL

Patents ADP number *(if you know it)* — 1198015

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application	Date of filing *(day / month / year)*

8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request? — Yes

Answer YES if:
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
Otherwise answer NO (See note d)

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form	
Description	27
Claim(s)	-
Abstract	-
Drawing(s)	7 + 7

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	-
Request for a preliminary examination and search (Patents Form 9/77)	-
Request for a substantive examination (Patents Form 10/77)	-
Any other documents (please specify)	-

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Murgitroyd & Co. Date 10 March 2004

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

Debi Brown
0141 307 8400
debi.brown@murgitroyd.com

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered YES in part 8, a Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) Part 7 should only be completed when a divisional application is being made under section 15(4), or when an application is being made under section 8(3), 12(6) or 37(4) following an entitlement dispute. By completing part 7 you are requesting that this application takes the same filing date as an earlier UK application. If you want the new application to have the same priority date(s) as the earlier UK application, you should also complete part 6 with the priority details.

Apparatus and Method for recovering fluids from a well

The present invention relates to a method and apparatus for recovering fluids from a well and injecting fluids into the well. The invention relates especially, but not exclusively, to simultaneous recovery and injection.

A flow diverter assembly for use in a well tree is known from our PCT Application No WO 00/70185. This discloses a flow diverter assembly which is located within the production bore of a tree. However, this means that the tree cap must first be removed before the flow diverter assembly is installed. Removing and repositioning the tree cap risks damage to the cap and requires costly preparation, as a secure tree cap is vital to control the pressure in the well, and if the tree cap were to be incorrectly replaced, a blow-out could occur.

Produced fluids from an oil well typically comprise a mixture of hydrocarbons, water and sand. At present, when production fluids are recovered, they are taken to the surface (e.g. a rig or even to land) before the hydrocarbons are separated from the unwanted sand and water. Conveying the sand and water such great distances is wasteful of energy. Furthermore, fluids to be injected into a well are often conveyed over significant distances, which is also a waste of energy.

According to a first aspect of the present invention there is provided a flow diverter assembly for a christmas tree, the flow diverter assembly comprising:

a flow diverter means to divert fluids from a first portion of a first flowpath to a second flowpath, and to divert fluids from the second flowpath back to a second portion of the first flowpath, the first portion of the first flowpath, the second flowpath and the second portion of the first flowpath forming a conduit for continuous passage of fluid;

wherein the flow diverter assembly is adapted to connect to a branch of the christmas tree.

The flow diverter assembly being adapted to connect to a branch of the tree means that the tree cap does not have to be removed to fit the flow diverter assembly. Embodiments of the invention can be easily retro-fitted to existing trees.

Typically, at least a part of the flow diverter assembly is adapted to be inserted within a choke body. Alternatively, the flow diverter assembly could be located in a branch of the tree (or a branch extension) in series with a choke. For example, the flow diverter assembly could be located between the choke and the production wing valve or between the choke and the branch outlet. Further alternative embodiments could have the diverter assembly located in pipework coupled to the tree, instead of within the tree itself. Such embodiments allow the flow diverter assembly to be used in addition to a choke, instead of replacing the choke.

Preferably, the flow diverter assembly is located within a bore in the branch of the christmas tree. Preferably, the flow diverter assembly comprises a conduit. Preferably, the conduit is adapted to be sealed within the branch bore. Preferably, the conduit divides the branch bore into two separate regions, so that the first portion of the first flowpath and the second portion of the first flowpath comprise the outside and the inside of the conduit respectively.

Typically, the flow diverter assembly has an outer cylindrical member. Preferably, one of the portions of the first flowpath comprises an annulus between the outer cylindrical member and the conduit. Preferably, one of the portions of the first flowpath comprises an interior bore of the conduit.

Typically, the second flow path comprises at least one conduit. Preferably, the second flow path comprises two conduits which lead to and from a processing apparatus.

Typically, the processing apparatus is selected from at least one of the group consisting of:
a pump; a process fluid turbine; injection apparatus for injecting gas or steam; chemical injection apparatus; a fluid riser; measurement apparatus; temperature measurement apparatus; flow rate measurement apparatus; constitution measurement apparatus; consistency measurement apparatus; gas separation apparatus; water separation apparatus; solids separation apparatus; and hydrocarbon separation apparatus.

According to a second aspect of the present invention there is provided a tree having:

a flow diverter assembly comprising a flow diverter means to divert fluids from a first portion of a first flowpath to a second flowpath, and to divert fluids from the second flowpath back to a second portion of the first flowpath, the first portion of the first flowpath, the second flowpath and the second portion of the first flowpath forming a conduit for continuous passage of fluid;

wherein the flow diverter assembly is connected to a branch of the christmas tree.

Typically, the flow diverter assembly is connected to a choke body in a branch of the christmas tree.

Alternatively, the flow diverter assembly is connected in series with a choke.

According to a third aspect of the present invention there is provided a method of diverting well fluids, the method including the steps of:

diverting fluids from a first portion of a first flowpath to a second flowpath and diverting the fluids from the second flowpath back to a second portion of the first flowpath;

wherein the fluids are diverted by at least one flow diverter assembly connected to a branch of the tree.

The flow diverter assembly is optionally located within a choke body; alternatively, the flow diverter assembly may be coupled in series with a choke. The flow diverter assembly may be located in the christmas tree branch adjacent to the choke, or it may be included within a separate extension portion of the christmas tree branch.

Typically, the method is for recovering fluids from a well, and includes the final step of diverting fluids to an outlet of the first flowpath for recovery therefrom. Alternatively or additionally, the method is for injecting fluids into a well.

For recovering production fluids, the first portion of the first flowpath is in communication with the production bore, and the second portion of the first flowpath is connected to a pipeline for carrying

away the recovered fluids (e.g. to the surface). For injecting fluids into the well, the first portion of the first flowpath is typically connected to an external fluid line, and the second portion of the first flowpath is in communication with the annulus bore. Optionally, the flow directions may be reversed.

Preferably, the first and second portions of the first flowpath comprise two separate regions within the branch of the tree. Typically, the fluids are diverted by a flow diverter assembly comprising a conduit, the two separate regions being the bore of the conduit, and the annulus between the conduit and the branch.

Optionally, the method includes the steps of recovering production fluids from a well and injecting at least a portion of the production fluids into a well. Optionally, at least a portion of the production fluids are returned to the same well.

For example, the production fluids could be separated into hydrocarbons and water; the hydrocarbons being returned to the first flowpath for recovery therefrom, and the water being returned and injected into the same, or a different, well.

Optionally, both of the steps of recovering fluids and injecting fluids include using respective flow diverter assemblies. Alternatively, only one of the

steps of recovering and injecting fluids includes using a flow diverter assembly.

Optionally, the method includes the step of diverting the fluids through a processing apparatus. Typically, the processing apparatus is selected from at least one of the group consisting of:
a pump; a process fluid turbine; injection apparatus for injecting gas or steam; chemical injection apparatus; a fluid riser; measurement apparatus; temperature measurement apparatus; flow rate measurement apparatus; constitution measurement apparatus; consistency measurement apparatus; gas separation apparatus; water separation apparatus; solids separation apparatus; and hydrocarbon separation apparatus.

According to a fourth aspect of the present invention, there is provided a christmas tree having a production bore and an annulus bore and:

a first diverter assembly in communication with the production bore;

a second diverter assembly in communication with the annulus bore;

wherein the first and second diverter assemblies are each adapted to divert fluids from a first portion of a respective first flowpath to a respective second flowpath, and to divert fluids from the respective second flowpath back to a second portion of the respective first flowpath, the first portion of the respective first flowpath, the respective second flowpath and the second portion of

the respective first flowpath forming a conduit for continuous passage of fluid.

Certain embodiments have the advantage that the first and second diverter assemblies can be connected together to allow the unwanted parts of the produced fluids (e.g. water and sand) to be directly injected back into the well, instead of being pumped away with the hydrocarbons. The unwanted materials can be extracted from the hydrocarbons substantially at the wellhead, which reduces the quantity of production fluids to be pumped away, thereby saving energy. The first and second diverter assemblies can alternatively or additionally be used to connect to other kinds of processing apparatus, such as a booster pump, filter apparatus, chemical injection apparatus, etc. to allow adding or taking away of substances and adjustment of pressure to be carried out adjacent to the wellhead. The first and second diverter assemblies enable processing to be performed on both fluids being recovered and fluids being injected. Preferred embodiments of the invention enable both recovery and injection to occur simultaneously in the same well.

Typically, the respective second flowpaths of the first and second diverter assemblies are connectable to allow the transfer of fluids between the first and the second diverter assemblies.

Typically, the respective second flowpaths of the first and second diverter assemblies comprise conduits connecting the first and second diverter assemblies to a processing apparatus.

Typically, the processing apparatus is selected from at least one of the group consisting of:
a pump; a process fluid turbine; injection apparatus for injecting gas or steam; chemical injection apparatus; a fluid riser; measurement apparatus; temperature measurement apparatus; flow rate measurement apparatus; constitution measurement apparatus; consistency measurement apparatus; gas separation apparatus; water separation apparatus; solids separation apparatus; and hydrocarbon separation apparatus.

Preferably, at least one of the first and second diverter assemblies is adapted to connect to a branch of the christmas tree.

Typically, at least a part of the first and second diverter assemblies are adapted to be inserted within a respective choke body, so that the diverter assemblies replace the choke. Alternatively the first and second diverter assemblies are connectable to a branch of the christmas tree in series with respective chokes.

Preferably, at least one of the first and second diverter assemblies comprises a conduit.
Preferably, the conduit is adapted to be located

within a bore of the christmas tree branch. Preferably the conduit is adapted be sealed within the bore of the christmas tree branch. Preferably, the conduit divides the bore of the christmas tree branch into two separate regions, so that the first portion of the first flowpath and the second portion of the first flowpath comprise the outside and the inside of the conduit.

Typically, at least one of the first and second diverter assemblies has a respective outer cylindrical member. Preferably, one of the first and second portions of the first flowpath comprises an annulus between the outer cylindrical member and the conduit and the other of the first and second portions of the first flowpath comprises an interior bore of the conduit.

Typically, a tubing system adapted to both recover and inject fluids is also provided. Preferably, the tubing system is adapted to simultaneously recover and inject fluids.

According to a fifth aspect of the present invention there is provided a method of recovering fluids from, and injecting fluids into, a well, the well having a tree including a production bore and an annulus bore, the method including the steps of:

using a first diverter assembly coupled to the production bore to divert production fluids from a first portion of a first flowpath to a second flowpath and to divert at least some of the

production fluids from the second flowpath back to a second portion of the first flowpath for recovery therefrom via an outlet of the first flowpath; and

using a second diverter assembly coupled to the annulus bore to divert injection fluids into the annulus bore.

Preferably, at least a part of the first flowpath comprises a branch of the tree.

Typically, at least one of the first and second flow diverter assemblies is coupled to a branch of the christmas tree. Typically, at least a part of at least one of the first and second flow diverter assemblies is located within a choke body. Optionally, the method also includes the step of passing at least some of the fluids through a choke.

Preferably, a processing apparatus is coupled to the second flowpath.

Typically, the processing apparatus is selected from at least one of the group consisting of:

a pump; a process fluid turbine; injection apparatus for injecting gas or steam; chemical injection apparatus; a fluid riser; measurement apparatus; temperature measurement apparatus; flow rate measurement apparatus; constitution measurement apparatus; consistency measurement apparatus; gas separation apparatus; water separation apparatus; solids separation apparatus; and hydrocarbon separation apparatus.

Preferably, the processing apparatus separates hydrocarbons from the rest of the produced fluids. Typically, the non-hydrocarbon components of the produced fluids are diverted to the second diverter assembly to provide at least one component of the injection fluids.

Optionally, at least one component of the injection fluids is provided by an external fluid line which is not connected to the production bore or to the first diverter assembly.

Optionally, the second diverter assembly diverts at least some of the injection fluids (typically fluids provided from an external fluid line) from a first portion of a first flowpath to a second flowpath and diverts the fluids from the second flowpath back to a second portion of the first flowpath for injection into the annulus bore of the well.

Typically, the steps of recovering fluids from the well and injecting fluids into the well are carried out simultaneously.

According to a sixth aspect of the invention there is provided a flow diverter assembly comprising a conduit adapted to be inserted within a christmas tree branch bore, such that the bore of the conduit defines a first flow region and the annulus between the conduit and the christmas tree branch bore defines a second flow region.

An embodiment of the invention will now be described, by way of example only, and with reference to the following drawings, in which:-

Fig 1 shows a cross-sectional view of a tree having a first diverter assembly coupled to a first branch of the tree and a second diverter assembly coupled to a second branch of the tree; and

Fig 2 shows a schematic view of the Fig 1 assembly used in conjunction with a first downhole tubing system;

Fig 3 shows an alternative embodiment of a downhole tubing system which could be used with the Fig 1 assembly;

Figs 4 and 5 show alternative embodiments of the invention, each having a flow diverter assembly coupled to a modified christmas tree branch between a choke and a production wing valve;

Figs 6 and 7 show further alternative embodiments, each having a flow diverter assembly coupled to a modified christmas tree branch below a choke; and

Fig 8 shows a first flow diverter assembly used to divert fluids from a first well and connected to an input header; and a second flow diverter assembly used to divert fluids from a second well and connected to an output header.

Referring to the drawings, Fig 1 shows a conventional tree 601 having a production bore 602 and an annulus bore 603.

The tree has a production wing 620 and associated production wing valve 610. The production wing 620 terminates in a production choke body 630. The production choke body 630 has an interior bore 607 extending therethrough in a direction perpendicular to the production wing 620. The bore 607 of the production choke body is in communication with the production wing 620 so that the choke body 630 forms an extension portion of the production wing 620. The opening at the lower end of the bore 607 comprises an outlet 612. In prior art trees, a choke is usually installed in the production choke body 630, but in the tree 601 of the present invention, the choke itself has been removed.

Similarly, the tree 601 also has an annulus wing 621, an annulus wing valve 611, an annulus choke body 631 and an interior bore 609 of the annulus choke body 631 terminating in an inlet 613 at its lower end. There is no choke inside the annulus choke body 631.

Attached to the production choke body 630 of the production wing 620 is a first flow diverter assembly 604 in the form of a production insert. The production insert 604 comprises a substantially cylindrical housing 640, a conduit 642, an inlet 646

and an outlet 644. The housing 640 has a reduced diameter portion 641 at an upper end and an increased diameter portion 643 at a lower end.

The conduit 642 has an inner bore 649, and forms an extension of the reduced diameter portion 641. The conduit 642 is longer than the housing 640 so that it extends beyond the end of the housing 640.

The space between the outer surface of the conduit 642 and the inner surface of the housing 640 forms an axial passage 647, which ends where the conduit 642 extends out from the housing 640. A connecting lateral passage is provided adjacent to the join of the conduit 642 and the housing 640; the lateral passage is in communication with the axial passage 647 of the housing 640 and terminates in the outlet 644.

The lower end of the housing 640 is attached to the upper end of the production choke body 630 at a clamp 648. The conduit 642 is sealingly attached inside the inner bore 607 of the choke body 630 at an annular seal 645.

Attached to the annular choke body 631 is a second flow diverter assembly 605. The second diverter assembly 605 is of the same form as the first diverter assembly 604, with the dimensions suitably adjusted to fit the smaller annulus choke body 631. The components of the second flow diverter assembly 605 are the same as those of the first flow diverter

assembly 604, including a housing 680 comprising a reduced diameter portion 681 and an enlarged diameter portion 683; a conduit 682 extending from the reduced diameter portion 681 and having a bore 689; an outlet 686; an inlet 684; and an axial passage 687 formed between the enlarged diameter portion 683 of the housing 680 and the conduit 682. A connecting lateral passage is provided adjacent to the join of the conduit 682 and the housing 680; the lateral passage is in communication with the axial passage 687 of the housing 680 and terminates in the inlet 684. The housing 680 is clamped by a clamp 688 on the annulus choke body 631, and the conduit 682 is sealed to the inside of the annulus choke body 631 at seal 685.

A conduit 690 connects the outlet 644 of the first diverter assembly 604 to a processing apparatus 700. In this embodiment, the processing apparatus 700 comprises bulk water separation equipment, which is adapted to separate water from hydrocarbons. A further conduit 692 connects the inlet 646 of the first diverter assembly 604 to the processing apparatus 700. Likewise, conduits 694, 696 connect the outlet 686 and the inlet 684 respectively of the second flow diverter assembly 605 to the processing apparatus 700. The processing apparatus 700 has pumps 820 fitted into the conduits between the separation vessel and the first and second flow diverter assemblies 604, 605.

The production bore 602 and the annulus bore 603 extend down into the well from the tree 601, where they are connected to a tubing system 800a, shown in Fig 2.

The tubing system 800a is adapted to allow the simultaneous injection of a first fluid into an injection zone 805 and production of a second fluid from a production zone 804. The tubing system 800a comprises an inner tubing 810 which is located inside an outer tubing 812. The production bore 602 is the inner bore of the inner tubing 810. The inner tubing 810 has perforations 814 in the region of the production zone 804. The outer tubing has perforations 816 in the region of the injection zone 805. A cylindrical plug 801 is provided in the annulus bore 603 which lies between the outer tubing 812 and the inner tubing 810. The plug 801 separates the part of the annulus bore 803 in the region of the injection zone 805 from the rest of the annulus bore 803.

In use, the produced fluids (typically a mixture of hydrocarbons and water) enter the inner tubing 810 through the perforations 814 and pass into the production bore 602. The produced fluids then pass through the production wing 620, the axial passage 647, the outlet 644, and the conduit 690 into the processing apparatus 700. The processing apparatus 700 separates the hydrocarbons from the water (and optionally other elements such as sand), e.g. using centrifugal separation.

The separated hydrocarbons flow into the conduit 692, from where they return to the first flow diverter assembly 604 via the inlet 646. The hydrocarbons then flow down through the conduit 642 and exit the choke body 630 at outlet 612, e.g. for removal to the surface.

The water separated from the hydrocarbons by the processing apparatus 700 is diverted through the conduit 696, the axial passage 687, and the annulus wing 611 into the annulus bore 603. When the water reaches the injection zone 805, it passes through the perforations 816 in the outer tubing 812 into the injection zone 805.

If desired, extra fluids can be injected into the well in addition to the separated water. These extra fluids flow into the second diverter assembly 631 via the inlet 613, flow directly through the conduit 682, the conduit 694 and into the processing apparatus 700. These extra fluids are then directed back through the conduit 696 and into the annulus bore 603 as explained above for the path of the separated water.

Fig 3 shows an alternative form of tubing system 800b including an inner tubing 820, an outer tubing 822 and an annular seal 821, for use in situations where a production zone 824 is located above an injection zone 825. The inner tubing 820 has perforations 836 in the region of the production

zone 824 and the outer tubing 822 has perforations 834 in the region of the injection zone 825.

The outer tubing 822, which generally extends round the circumference of the inner tubing 820, is split into a plurality of axial tubes in the region of the production zone 824. This allows fluids from the production zone 824 to pass between the axial tubes and through the perforations 836 in the inner tubing 820 into the production bore 602. From the production bore 602 the fluids pass upwards into the tree as described above. The returned injection fluids in the annulus bore 603 pass through the perforations 834 in the outer tubing 822 into the injection zone 825.

Figs 4 to 7 illustrate alternative embodiments where the flow diverter assembly is not inserted within a choke body. These embodiments therefore allow a choke to be used in addition to the flow diverter assembly.

Fig 4 shows a tree 900 having a production bore 902, a production wing branch 920, a production wing valve 910, an outlet 912 and a production choke 930. The production choke 930 is a full choke, fitted as standard in many christmas trees, in contrast with the production choke body 630 of the Fig 1 embodiment, from which the actual choke has been removed. In Fig 4, the production choke 930 is shown in a fully open position.

A flow diverter assembly 904 in the form of a production insert is located in the production wing branch 920 between the production wing valve 910 and the production choke 930. The flow diverter assembly 904 is the same as the flow diverter assembly 604 of the Fig 1 embodiment, and like parts are designated here by like numbers, prefixed by "9". Like the Fig 1 embodiment, the Fig 4 housing 940 is attached to the production wing branch 920 at a clamp 948.

The lower end of the conduit 942 is sealed inside the production wing branch 920 at a seal 945. The production wing branch 920 includes a secondary branch 921 which connects the part of the production wing branch 920 adjacent to the diverter assembly 904 with the part of the production wing branch 920 adjacent to the production choke 930. A valve 922 is located in the production wing branch 920 between the diverter assembly 904 and the production choke 930.

The combination of the valve 922 and the seal 945 prevents production fluids from flowing directly from the production bore 902 to the outlet 912. Instead, the production fluids are diverted into the axial annular passage 947 between the conduit 942 and the housing 940. The fluids then exit the outlet 944 into a processing apparatus (examples of which are described above), then re-enter the diverter assembly via the inlet 946, from where they

pass through the conduit 942, through the secondary branch 921, the choke 930 and the outlet 912.

Fig 5 shows an alternative embodiment of the Fig 4 design, and like parts are denoted by like numbers having a prime. In this embodiment, the valve 922 is not needed because the secondary branch 921′ continues directly to the production choke 930′, instead of rejoining the production wing branch 920′. Again, the diverter assembly 904′ is sealed in the production wing branch 920′, which prevents fluids from flowing directly along the production wing branch 920′, the fluids instead being diverted through the diverter assembly 904′.

Fig 6 shows a further embodiment, in which a diverter assembly 1004 is located in an extension 1021 of a production wing branch 1020 beneath a choke 1030. The diverter assembly 1004 is the same as the diverter assemblies of Figs 4 and 5; it is merely rotated at 90 degrees with respect to the production wing branch 1020.

The diverter assembly 1004 is sealed within the branch extension 1021 at a seal 1045. A valve 1022 is located in the branch extension 1021 below the diverter assembly 1004.

The branch extension 1021 comprises a primary passage 1060 and a secondary passage 1061, which departs from the primary passage 1060 on one side of

the valve 1022 and rejoins the primary passage 1060 on the other side of the valve 1022.

Production fluids pass through the choke 1030 and are diverted by the valve 1022 and the seal 1045 into the axial annular passage 1047 of the diverter assembly 1004 to an outlet 1044. They are then typically processed by a processing apparatus, as described above, and then they are returned to the bore 1049 of the diverter assembly 1004, from where they pass through the secondary passage 1061, back into the primary passage 1060 and out of the outlet 1012.

Fig 7 shows a modified version of the Fig 6 apparatus, in which like parts are designated by the same reference number with a prime. In this embodiment, the secondary passage 1061′ does not rejoin the primary passage 1060′; instead the secondary passage 1061′ leads directly to the outlet 1012′. This embodiment works in the same way as the Fig 6 embodiment.

The embodiments of Figs 6 and 7 could be modified for use with a conventional christmas tree by incorporating the diverter assembly 1004, 1004′ into further pipework attached to the tree, instead of within an extension branch of the tree.

Fig 8 illustrates an alternative method of using the flow diverter assemblies in the recovery of fluids from multiple wells. The flow diverter assemblies

can be any of the ones shown in the previously illustrated embodiment, and are not shown in detail in this Figure; for this example, the flow diverter assemblies are the production flow diverter assemblies of Fig 1.

A first diverter assembly 704 is connected to a branch of a first production well A. The diverter assembly 704 comprises a conduit (not shown) sealed within the bore of a choke body to provide a first flow region inside the bore of the conduit and a second flow region in the annulus between the conduit and the bore of the choke body. It is emphasised that the flow diverter assembly 704 is the same as the flow diverter assembly 604 of Fig 1; however it is being used in a different way, so some outlets of Fig 1 correspond to inlets of Fig 8 and vice versa.

The bore of the conduit has an inlet 712 and an outlet 746 (inlet 712 corresponds to outlet 612 of Fig 1 and outlet 746 corresponds to inlet 646 of Fig 1). The inlet 712 is in communication with an input header 701. The input header 701 may contain produced fluids from several other production wells (not shown).

The annular passage between the conduit and the choke body is in communication with the production wing branch of the tree of the first well A, and with the outlet 744 (which corresponds to the outlet 644 in Fig 1).

Likewise, a second diverter assembly 714 is connected to a branch of a second production well B. The second diverter assembly 714 is the same as the first diverter assembly 704, and is located in a production wing branch in the same way. The bore of the conduit of the second diverter assembly has an inlet 756 (corresponding to the inlet 646 in Fig 1) and an outlet 722 (corresponding to the outlet 612 of Fig 1). The outlet 722 is connected to an output header 703. The output header 703 is a conduit for conveying the produced fluids to the surface, for example, and may also be fed from several other wells (not shown).

The annular passage between the conduit and the inside of the choke body connects the production wing branch to an outlet 754 (which corresponds to the outlet 644 of Fig 1).

The outlets 746, 744 and 754 are all connected via tubing to the inlet of a pump 750. Pump 750 then passes all of these fluids into the inlet 756 of the second diverter assembly 714. Optionally, further fluids from other wells (not shown) are also pumped by pump 750 and passed into the inlet 756.

In use, the second diverter assembly 714 functions in the same way as the diverter assembly 604 of the Fig 1 embodiment. Fluids from the production bore of the second well B are diverted by the conduit of the second flow diverter assembly 714 into the

annular passage between the conduit and the inside of the choke body, from where they exit through outlet 754, pass through the pump 750 and are then returned to the bore of the conduit through the inlet 756. The returned fluids pass straight through the bore of the conduit and into the outlet header 703, from where they are recovered.

The first diverter assembly 704 functions differently because the produced fluids from the first well 702 are not returned to the first flow diverter assembly 704 once they leave the outlet 744 of the annulus. Instead, both of the flow regions inside and outside of the conduit have fluid flowing in the same direction. Inside the conduit (the first flow region), fluids flow upwards from the input header 701 straight through the conduit to the outlet 746. Outside of the conduit (the second flow region), fluids flow upwards from the production bore of the first well 702 to the outlet 744.

Both streams of upwardly flowing fluids combine with fluids from the outlet 754 of the second diverter assembly 714, from where they enter the pump 750, pass through the second diverter assembly into the outlet header 703, as described above.

Modifications and improvements can be incorporated without departing from the scope of the invention. For example, the tree 1 is a conventional tree but the invention can also be used with horizontal trees.

One or both of the flow diverter assemblies of the Fig 1 embodiment could be located within the production bore and/or the annulus bore, instead of within the production and annular choke bodies.

The processing apparatus 700 could be one or more of a wide variety of equipment. For example, the processing apparatus 700 could comprise a pump or process fluid turbine, for boosting the pressure of the fluid. Alternatively, or additionally, the processing apparatus could inject gas or steam into the well fluids. The injection of gas could be advantageous, as it would give the fluids "lift", making them easier to pump. The addition of steam has the effect of adding energy to the fluids. The processing apparatus 700 could also enable chemicals to be added to the well fluids, e.g. viscosity moderators, which thin out the produced fluids, making them easier to pump, or pipe skin friction moderators, which minimise the friction between the fluids and the pipes. The chemicals/ injected materials could be added via one or more additional input conduits. The processing apparatus 700 could also comprise a fluid riser, which could provide an alternative route to the surface for the produced fluids. The processing equipment could alternatively or additionally include measurement apparatus, e.g. for measuring the temperature/flow rate/constitution/ consistency, etc. The separation equipment may be adapted to separated gas, water, sand/debris and/or hydrocarbons.

The pumps 820 are optional.

The above described flow paths could be completely reversed or redirected for other process requirements.

The tubing system 800a, 800b could be any system which allows both production and injection; the system is not limited to the examples given above. Optionally, the tubing system could comprise two conduits which are side by side, instead of one inside the other, one of the conduits providing the production bore and the second providing the annulus bore.

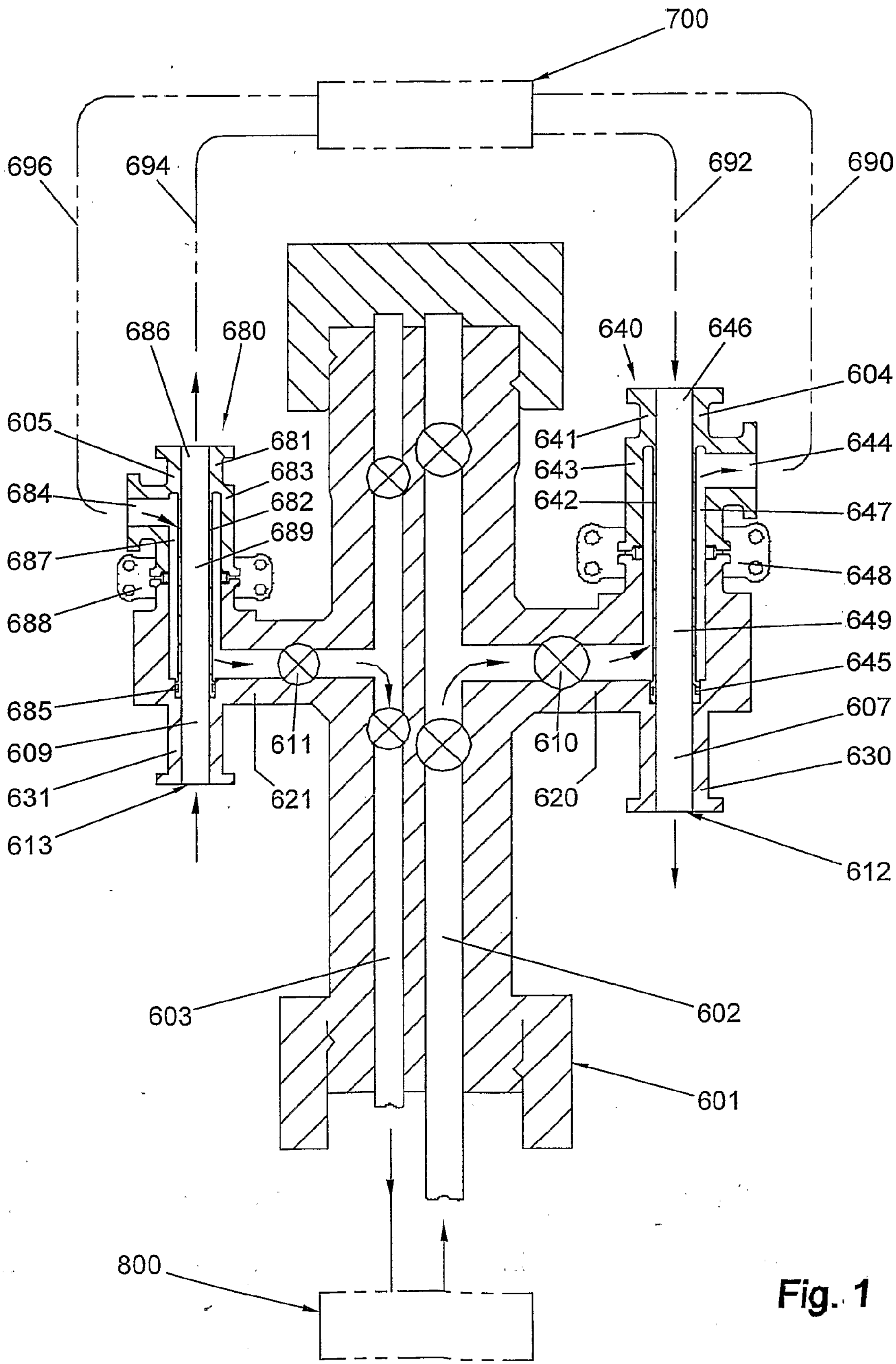

700
696
694
692
690
686
680
640
646
604
605
681
683
641
643
644
684
682
642
647
689
687
648
688
649
645
685
611
610
607
609
631
621
620
630
613
612
603
602
601
800

Fig. 1

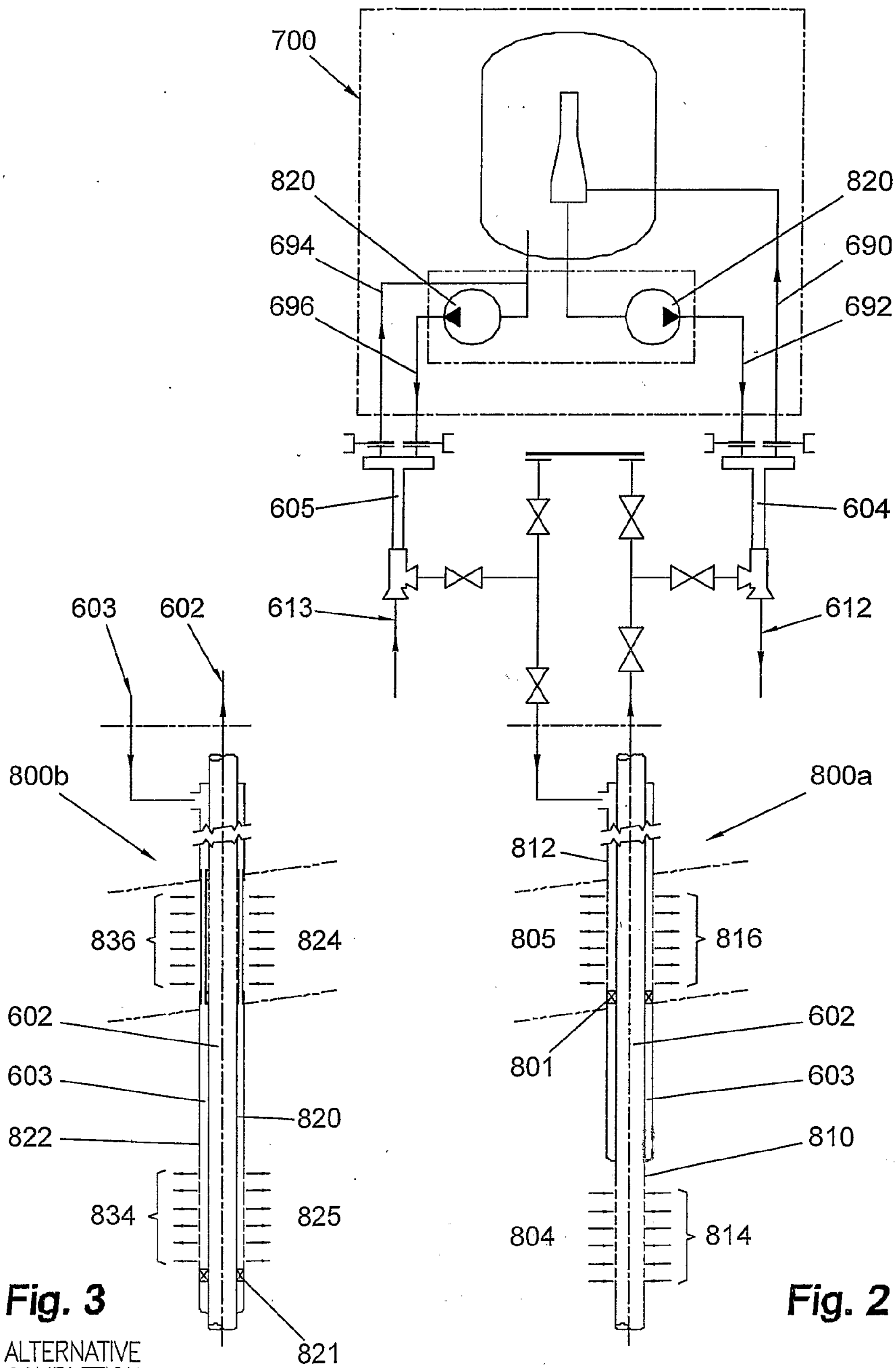


Fig. 3

ALTERNATIVE COMPLETION.

Fig. 2

SUBSEA TREE, MARS
HORIZONTAL LINE INSERT
c/w ADDITIONAL VALVE.

Fig 4

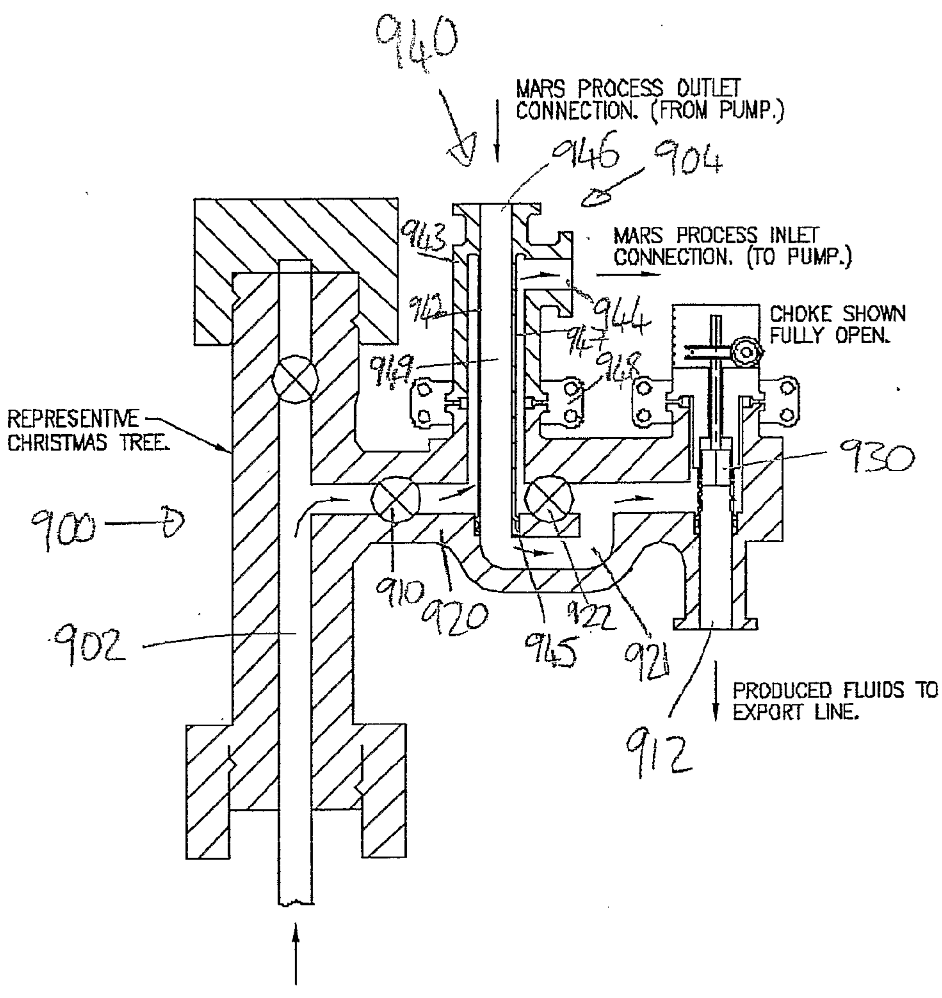
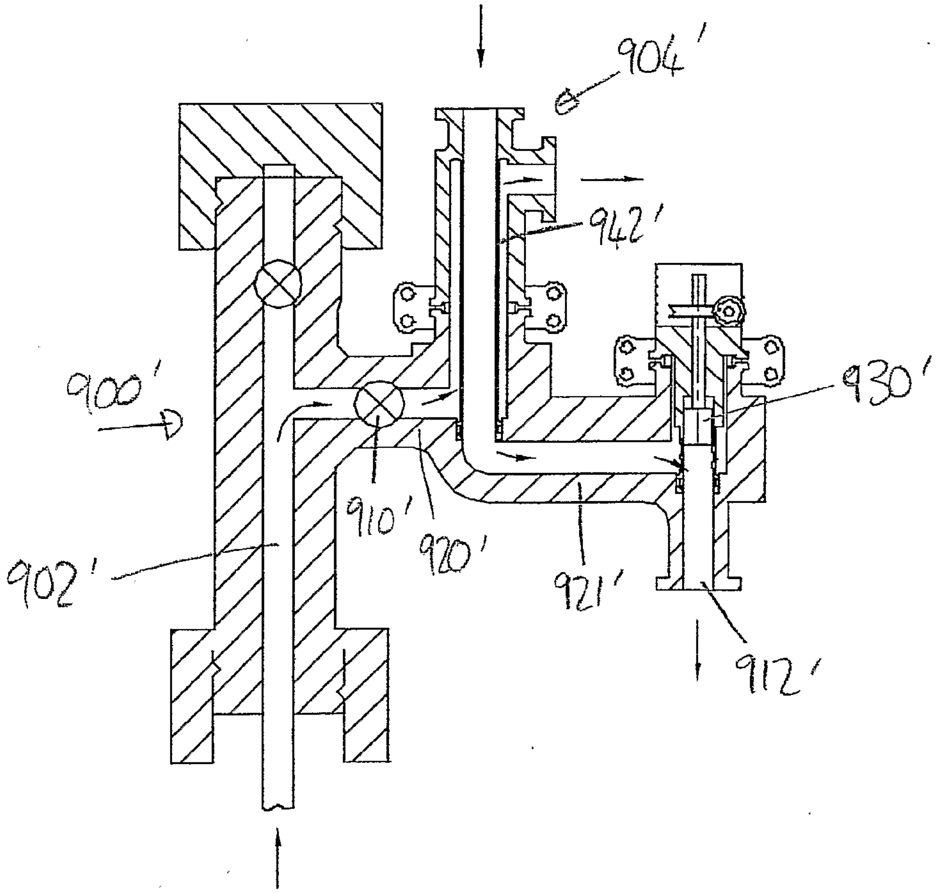


Fig 5

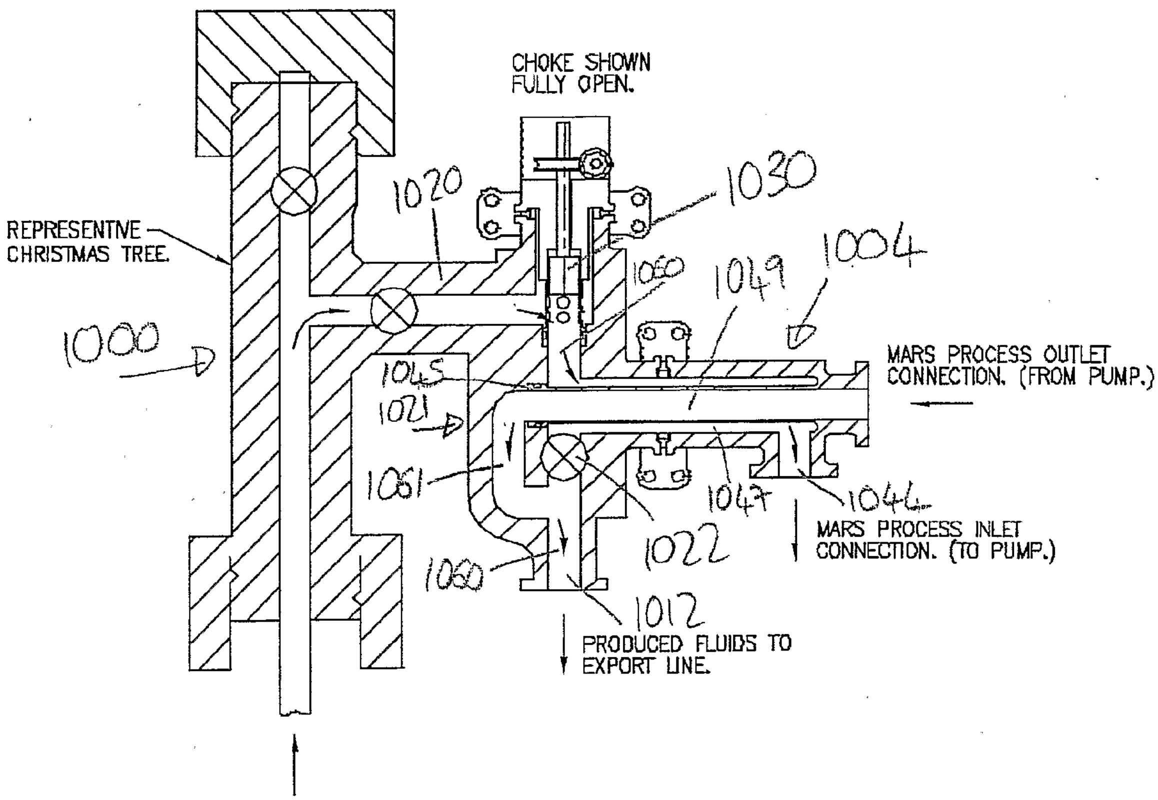
SUBSEA TREE, MARS
HORIZONTAL LINE INSERT.



5/7

SUBSEA TREE, MARS
VERTICAL LINE INSERT
c/w ADDITIONAL VALVE.

Fig 6



SUBSEA TREE, MARS
VERTICAL LINE INSERT.

Fig 7

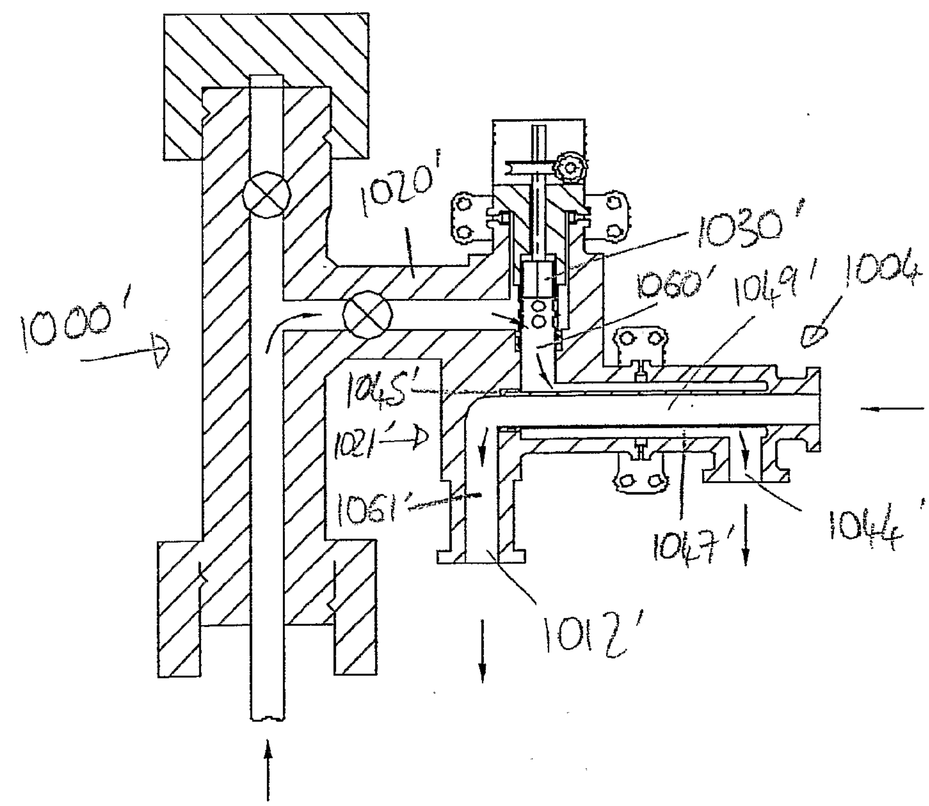


Fig8